## WEATHER FORECASTING IN THE UNITED STATES.[1]

The above is the title of a volume which has long been desired by American students of the weather. Although weather forecasts have been made in the United States since 1854 when Joseph Henry began to collect daily telegraphic reports at the Smithsonian Institution, there is but little in writing to explain the details of the processes by which daily weather forecasts are made to-day. Much of the experience of our forecasters has remained locked within their own bosoms, and death has destroyed forever much valuable knowledge and experience needed by the science and art.

Realizing the need for a written record of such experience and knowledge in this line as the Weather Bureau possesses, the present Chief of Bureau called upon the staff of forecasters in November, 1913, to submit illustrated essays on forecasting in those fields familiar to each.

These essays were taken in hand by a board appointed in August, 1914, that has worked them over under the leadership of its chairman, Prof. A. J. Henry, into a volume which is meant to aid the beginner in the art as well as to record the rules and considerations found useful by the experienced forecasters of this bureau.

Two preliminary chapters open the work: Chapter I, dealing with the problems of atmospheric motions, particularly as influenced by the earth's rotation, is by C. F. Marvin; Chapter II, by W. J. Humphreys, deals in a general way with the general circulation of the atmosphere and presents, by implication, a new classification of the winds, at the same time offering some new definitions of old classes.

The relation of atmospheric pressure distribution and of certain well-known barometric configurations to subsequent weather is discussed by A. J. Henry in chapters III, IV, and V. Chapter IV, on auxiliary pressure-change charts, will be particularly interesting to European meteorologists since it is perhaps the first printed exposition of American experience with these charts, although the Weather Bureau began to construct and use them as early as 1872.

The well-marked weather phenomena, such as cold waves, frosts, high winds, fog, snow, sleet (Eiskörner), ice storms (glaze or Glatteis), and thunderstorms, are discussed chiefly by H. J. Cox, H. C. Frankenfield, and E. H. Bowie. The peculiarities of the routine forcasting work for each of the six forecast districts are discussed in Chapters X, XI, XII, by the respective District Forecasters in charge; and the text closes with Chapter XIII on long-range forecasts by District Forecaster E. H. Bowie, who presents the guiding precepts underlying the safe, conservative weekly forecasts now issued by the bureau.

The work is generously illustrated by small-scale maps and diagrams, many of them in two colors, to the number of 200; it also has a short glossary of terms used in this work, a selected list of works in English on forecasting, and an index.

The editor, Prof. A. J. Henry, states in his preface:

> The book will be a disappointment to those, if there be such, who have formed the expectation that it will solve the difficulties of the forecasting problem. The consensus of opinion seems to be that the only road to successful forecasting lies in the patient and consistent study of the daily weather maps. Wherein the book will be helpful, however, is in the fact that it gives the experience of those who have gone before, and it is in this sense that it will find its most useful application.—C. A., jr.

[1] *United States. Weather Bureau.* Weather forecasting in the United States. By a board composed of Alfred J. Henry, chairman, Edward H. Bowie, Henry J. Cox, Harry C. Frankenfield. Washington, 1916. 370 p. 199 figs. fr. p. 4°. (Weather Bureau number 583.) Price, $0.85.

## THE PERSISTENCE OF WET AND DRY WEATHER.[1]

By E. V. NEWNHAM, B. Sc., F. R. Met. Soc.

[Abstract.]

In this paper an attempt is made to analyze the rainfall records of several British stations with the help of modern statistical methods in order to find out to what extent the tendency for wet and fine (fair) days to occur in "runs" can assist in forecasting rain in the near future.

It can be shown that the rainfall of one day is not independent of that of the next. For example, by the law of chance 41 runs of 6 "rain days" should be expected at Kew in 10 years and the chances are rather against a run of 12 days occurring at all; actually there were 181 runs of 6 and 12 runs of 12 successive "rain days."

An examination of the records shows that the chance of any given day being a "rain day" is increased somewhat beyond the normal by the fact of the preceding day having been wet. The records of Aberdeen, Kew, and Valencia for 1901–1910 and of Greenwich for 1887–1913 have been examined in detail. The results show that the chance of the succeeding day being a "rain day" increases with the length of the run. It does not appear to have reached a constant value after a spell of nine successive "rain days" but is still rising slowly. The observations in these regions are, however, too few to warrant any conclusions being drawn as to the precise form of the curve here.

The author concludes that during a long spell of wet weather there are no grounds for expecting finer conditions merely because the unsettled weather has lasted so long; and similarly that during fine weather the chances of continued drought become greater the longer the fine weather lasts, at any rate for spells of a length commonly met with. What happens when the length of the spell reaches a quite abnormal value must remain doubtful, but it seems reasonable to suppose the probability reaches a constant value.—*W. G. Reed.*

## NEW SOUTH WALES RAINFALL.[2]

By D. J. MARES.

[Commonwealth Bureau of Meteorology, Melbourne.]

### SOME PECULIARITIES IN THE ANNUAL DISTRIBUTION.

The average annual isohyetal chart of New South Wales brings out prominently the four main rainfall regions, viz, the Great Plains, the Mountain Slopes, the Tablelands, and the Eastern Areas. Studying the chart from west to east, it is evident that a considerable area comprising the Great Plains and the Tablelands, receives annual totals which vary almost in proportion to the altitude. The rainfall of a country is of course affected by the proximity to the sea as well as elevation; but, notwithstanding the rainfall of New South Wales west of the mountains is largely controlled by elevation, a very small percentage of western rain crosses the highlands to the coast and coastal rains rarely penetrate to the western districts except through the Cassilis geocol. In general, the altitudes of stations on the great western plains are

[1] Published in Quarterly Journal of the Royal Meteorological Society, London, July, 1916, 42: 153–162.

[2] *Reprinted from* pp. 20–21 of "Results of rainfall observations made in New South Wales during 1909–1914, . . . by H. A. Hunt, Commonwealth Meteorologist." Melbourne, 1916. 224p. plates. 29½cm. (Australia. Commonwealth Bureau of Meteorology.)

The sketch map of physiographic districts of New South Wales (fig. 1) has been prepared by the Editor from the annual Rain Map of Australia.

about 500 feet, and of the Tablelands to the eastward, between 2,000 and 3,000 feet.

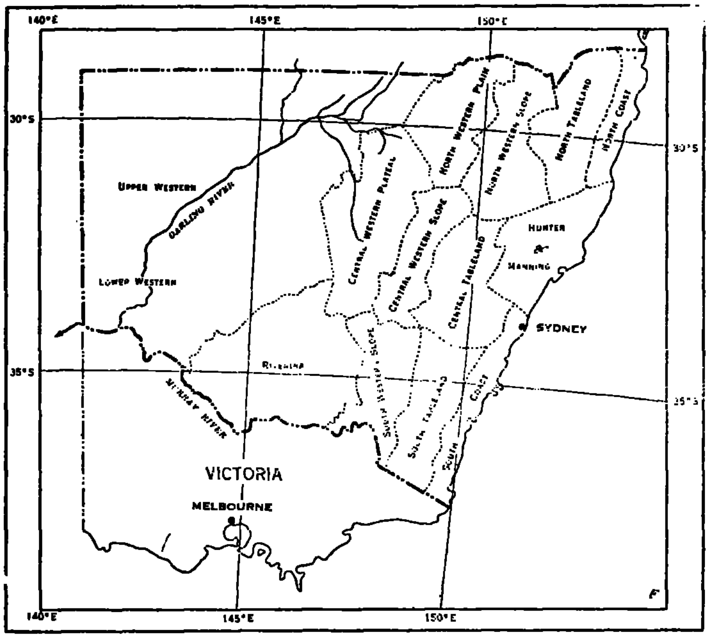


FIG. 1.—Physiographic provinces of New South Wales.

Considering the various subdivisions of the State—viz, those used mostly for meteorological purpose—it is seen that the Western Division, or that section with the least altitude, has an average annual rainfall varying between 6 inches (on the far northwestern borders) to about 19 inches in the vicinity of Mogil and Collarenebri (in the northeast corner of that division). The majority of the stations, however, possess yearly amounts of from 8 to 12 inches.

The Riverina ranks next as an area of comparatively low rainfall, the average for the whole division being about 16½ inches, and the extremes from 11 inches at Maude to 22 inches at Howlong.

A division with only 2½ inches more, on the average, than the Riverina is the Central-Western Plain, viz, 19 inches. There is more uniformity in the rainfall of this district than in the case of the preceding ones; the lowest average amount being 15.83 inches at Carinda, and the highest 24.35 inches at Gilgandra.

Next in order of amount comes the Northwestern Plains, with an average of 22.22 inches, and a range in extremes of about 7½ inches. If these four divisions are considered as constituting the Great Plains, the average of the whole area becomes 16.24 inches.

From the Great Plains to the Slopes there is an appreciable increase of about 8 inches in the rainfall, the Northern Division receiving most, viz, 27.86 inches, as against 24.23 inches for the central portion and 23.97 for the southern parts.

The highest annual averages on the Slopes are 38.12 inches at Tumbarumba and 30.96 inches at Tumut, both on the Southwestern Slopes. So that, taking the lowest rainfall in the State, viz, 5.46 inches at Mokely, and the largest on the Slopes, 52.59 inches at Laurel Hill, near Batlow, there is an extreme range of 47.13 inches.

Working up the Slopes to the Tablelands, the rainfall increases considerably, but more so on the central and northern than in the southern parts. The mean average of the whole of the Tablelands is 31.40 inches. Kiandra, on the Southern Tablelands (Australian Alps), with an altitude of about 46.40 feet, has the heaviest fall, viz, 64.11 inches. A remarkable peculiarity in regard to this total is its great predominance over that of near-by Cooma, which has only 19.13 inches, one of the lowest totals on the Tablelands. These disparities are mainly due to the geographical aspect of the respective stations in relation to the source of the rainfall.

### THE COASTAL REGIONS.

Working still farther eastward to the coastal regions, and therefore nearer to the Pacific Ocean, there is a marked increase in the amount of rainfall. This tract of the State—which covers an area of 29,734 square miles—is subdivided into four main districts, viz, the North Coast, the Hastings Hunter and Manning, the Metropolitan, and the South Coast. Of these the North Coast District has the largest annual average, viz, 50.20 inches, the maximum amount being recorded at Bilambil, 80.03 inches. The smallest is in the neighborhood of Grafton, some miles inland.

### SEASONAL RAINFALL DISTRIBUTION.

The foregoing notes on the annual rain variations deserve careful consideration from an economic standpoint, but a knowledge of the rain distribution throughout the year is most important, and is in fact essential to a true estimation of the economic possibilities of the State.

The main controlling factors in the seasonal distribution of rain have been discussed for Australia in general, in the volume "Climate and Weather of Australia," recently published by the Meteorological Bureau, and here it may be of interest to give fuller details respecting New South Wales. The following table has therefore been compiled, and will afford data for a closer study of the effects of the various pressure systems peculiar to the respective seasons, and for the correction [correlation?] of the rainfall with the physiographic features of the State.

Table 1 shows the normal annual and normal seasonal rainfall in each of the 30 districts into which the State has been divided, and gives the percentage of the yearly fall recorded in each season.

TABLE 1.—*Normal annual and seasonal rainfalls of New South Wales, in inches and percentages of the annual falls.*[3]

| Subdivisions. | Average annual rainfall. | Spring. | | Summer. | | Fall. | | Winter. | |
|---|---|---|---|---|---|---|---|---|---|
| | *Ins.* | *Ins.* | *Perct.* | *Ins.* | *Perct.* | *Ins.* | *Perct.* | *Ins.* | *Perct.* |
| Trans-Darling North | 8.86 | 1.93 | 21.8 | 2.74 | 30.9 | 2.14 | 24.2 | 2.05 | 23.1 |
| Trans-Darling South | 9.99 | 2.42 | 24.2 | 2.36 | 23.6 | 2.46 | 24.6 | 2.75 | 27.5 |
| Cis-Darling North | 14.38 | 2.96 | 20.6 | 4.80 | 33.4 | 3.62 | 25.2 | 3.00 | 20.8 |
| Cis-Darling South | 12.92 | 2.93 | 22.7 | 3.31 | 25.6 | 3.30 | 25.5 | 3.38 | 26.2 |
| Upper Bogan | 18.71 | 3.87 | 20.7 | 5.41 | 28.9 | 5.05 | 27.0 | 4.38 | 23.4 |
| Lower Macquarie | 18.01 | 3.51 | 19.5 | 5.77 | 32.0 | 4.86 | 27.0 | 3.87 | 21.5 |
| West Gwydir | 19.71 | 4.38 | 22.2 | 6.49 | 32.9 | 4.92 | 25.0 | 3.92 | 19.9 |
| East Gwydir | 23.94 | 5.08 | 21.2 | 7.78 | 32.5 | 6.42 | 26.8 | 4.66 | 19.5 |
| Mandewars | 27.19 | 5.95 | 21.9 | 8.74 | 32.1 | 6.85 | 25.2 | 5.65 | 20.8 |
| Liverpool Plains | 26.30 | 6.31 | 24.0 | 8.05 | 30.6 | 6.20 | 23.6 | 5.74 | 21.8 |
| West New England | 31.65 | 8.00 | 25.3 | 10.50 | 33.2 | 6.73 | 21.3 | 6.42 | 20.3 |
| East New England | 38.33 | 7.94 | 20.7 | 15.22 | 39.7 | 9.86 | 25.7 | 5.31 | 13.9 |
| Clarence | 52.80 | 8.79 | 16.6 | 17.71 | 33.5 | 16.26 | 30.8 | 10.04 | 19.0 |
| Orara | 54.47 | 10.09 | 18.5 | 16.31 | 30.0 | 17.92 | 32.9 | 10.15 | 18.6 |
| Manning | 53.46 | 10.05 | 18.8 | 16.37 | 30.6 | 15.60 | 29.2 | 11.44 | 21.4 |
| Hunter | 37.08 | 7.64 | 20.6 | 9.89 | 26.7 | 10.66 | 28.7 | 8.89 | 24.0 |
| Cudgegong | 24.44 | 5.75 | 23.5 | 7.33 | 30.0 | 5.74 | 23.5 | 5.62 | 23.0 |
| Central Plateau | 28.12 | 6.91 | 24.6 | 7.05 | 25.1 | 6.35 | 22.6 | 7.81 | 27.7 |
| Warrumbungles Highlands | 28.19 | 6.13 | 21.8 | 8.68 | 30.8 | 6.86 | 24.3 | 6.52 | 23.1 |
| Warren Lowlands | 21.35 | 5.07 | 23.7 | 5.65 | 26.5 | 5.35 | 25.1 | 5.28 | 24.7 |
| Sydney | 39.05 | 7.35 | 18.8 | 10.83 | 27.7 | 11.60 | 29.7 | 9.27 | 23.8 |
| Nepean | 30.71 | 6.15 | 20.0 | 8.74 | 28.5 | 9.01 | 29.3 | 6.81 | 22.2 |
| Illawarra | 55.65 | 10.24 | 18.4 | 11.78 | 21.2 | 18.65 | 33.5 | 14.98 | 26.9 |
| South Coast | 34.44 | 7.44 | 21.6 | 8.84 | 25.7 | 9.90 | 28.7 | 8.26 | 24.0 |
| Upper Murrumbidgee | 23.90 | 5.67 | 23.7 | 6.48 | 27.2 | 5.65 | 23.6 | 6.10 | 25.5 |
| Snowy Mountains | 63.44 | 18.04 | 28.4 | 11.35 | 17.9 | 13.79 | 21.8 | 20.26 | 31.9 |
| Jugiong | 28.12 | 6.97 | 24.8 | 5.31 | 18.9 | 6.74 | 23.9 | 9.10 | 32.4 |
| Tumut | 22.20 | 5.52 | 24.9 | 4.89 | 22.0 | 5.34 | 24.1 | 6.45 | 29.0 |
| East Riverina | 16.67 | 4.04 | 24.2 | 3.42 | 20.5 | 4.28 | 25.7 | 4.93 | 29.6 |
| West Riverina | 12.97 | 3.04 | 23.4 | 2.58 | 19.9 | 3.41 | 26.3 | 3.94 | 30.4 |

[3] The "points" of the original tables are here stated as *inches* for the convenience of American readers.

An inspection of the table shows, for example, those areas which are indebted to the Summer months (December, January, and February) for most of their rainfall and those which owe most to the Fall and Winter.

In the following subdivisions Summer is the wettest season: Trans-Darling North, Cis-Darling North, Upper Bogan, Lower Macquarie, West Gwydir, East Gwydir, Mandewars, Liverpool Plains, West New England, East New England, Clarence, Manning, Cudgegong, Wurrumbungles Highlands, Warren Lowlands, and Upper Murrumbidgee—roughly speaking, all the northern half of the State.

The Fall or Winter is best favored in Trans-Darling South, Cis-Darling South, Orara, Hunter, Central Plateau, Sydney, Nepean, Illawarra, South Coast, Snowy Mountain, Jugiong, Tumut, East Riverina, and West Riverina—mostly in the southern half of New South Wales.

In no instance does the Spring rainfall predominate, although in the majority of cases it exceeds 20 per cent of the annual. The smallest percentage in Spring is experienced in the Clarence subdivision, where it amounts to only 16.6 per cent of the annual total. The greatest in this season occurs on the Snowy Mountains, with 28.4 per cent.

The largest Summer percentage is 39.7 per cent in East New England and the least, 17.9 per cent, on the Snowy Mountains.

In the Fall, during which the rainfall is perhaps the best distributed, the greatest percentage falls in the Illawarra district—viz, 33.5 inches—and the least, 21.3 per cent, in West New England.

Winter, the season of southern rains, has 32.4 at Jugiong as its largest percentage and 13.9 per cent, the least, in East New England. It will be seen that in the latter district the two extremes are experienced, both in Summer and Winter.

Monsoonal and Antarctic influences, acting either separately or in combination, are responsible for the rainfall in New South Wales. The monsoonal rainstorms favor as their period of operation the warm months of the year and mostly affect northern districts, while the Antarctic disturbances, although perennial, are in their best form during the Winter and yield their largest falls in southern areas.

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### "ACT OF GOD" DEFINED.[1]

The term "act of God," as applicable to the question of damages, has received a variety of definitions.

Some courts hold such acts to be those occasioned exclusively by the violence of nature, such as floods, lightning, tornado, earthquake, and the like. Another phase of the same idea is the statement that it is a disaster with which the agency of man had nothing to do. Everyone, however, is supposed to take reasonable precautions, such as a prudent man would take in like cases. Then if the act of nature causes loss and damage, there is no wrong and no liability can attach to any one.

A comprehensive definition of "act of God" is found in the case of United States *v.* Kansas, etc., Ry. Co. (189 Fed., 471, 477), as follows:

> An inevitable accident which could not have been foreseen and prevented by the exercise of that degree of diligence which reasonable men would exercise under like conditions and without any fault attributable to the party sought to be held responsible.

See also 1 Corpus Juris, 1177, and cases cited.

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[1] *From* "Reclamation Record," Washington, September, 1916, No. 9, 7: 398-9.